Mathematica

Throughout the course, you may find it useful to use the math package Mathematica for plotting, or checking your calculations. I will post on the Physics 303 web page examples of Mathematica calculations that are related to the course work. I encourage you to use version 5.2 of this program, which is loaded on computers in the Physics Department lounge, to develop familiarity with its capabilities and to add it to the various tools at your disposal to solve problems in the physical sciences.

To run Mathematica, double click on the icon on the desktop. The illustration below shows how to generate simple plots.

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In[1]:= Plot[Sin[x], {x, 0, 2 Pi}]
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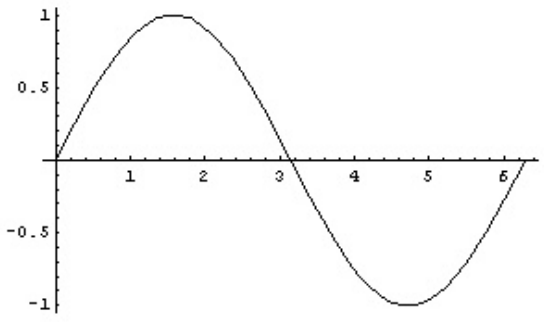


```
Out[1]= - Graphics -

In[12]:= y[t_] = t^2;
         y2[t_] = 2;
         Plot[{y[t], y2[t]}, {t, 0, 2}]
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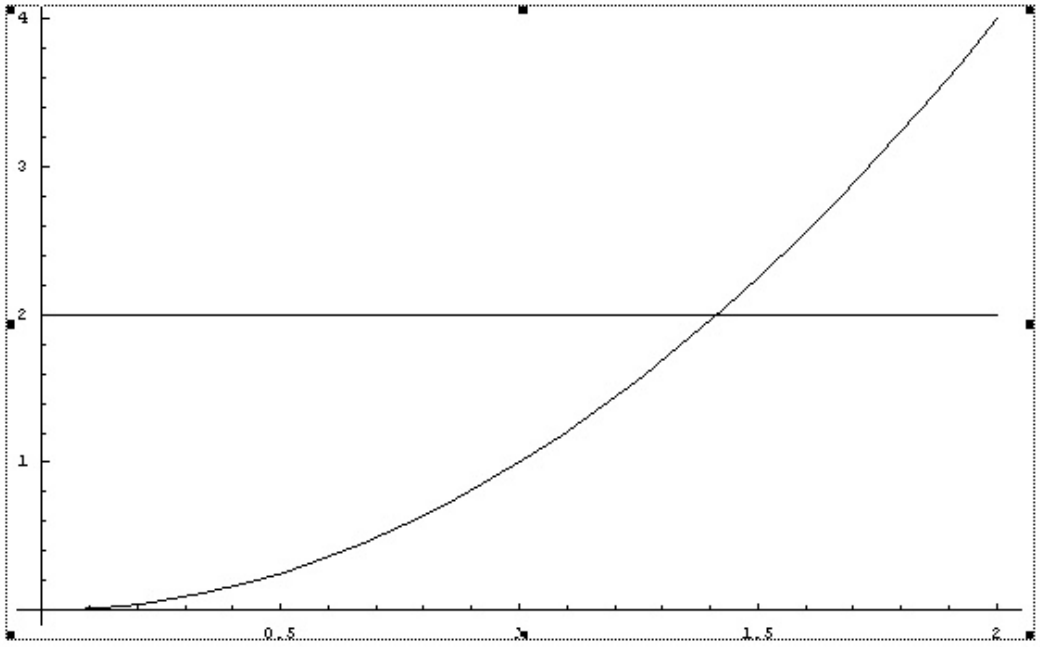

Explanation of the commands.

One of very useful built in functions in Mathematica is the function Plot[]. This function has two comma-separated arguments. The first argument is the function(s) to plot, and the second argument is the numerical range of the function(s) variable over which to plot the function(s).

(Note that ALL Mathematica built in functions begin with a capital letter, and their arguments are ALL enclosed in the square brackets [and].)

Now what is it that we want to plot? In the first example, we will plot another Mathematica built in function Sin[x]. So we type Plot[Sin[x], {x, 0, 2 Pi}].
(Note the square brackets around the argument of Sin. Also, the variable is arbitrary; it could just as well be y or t or any other variable name.)

The second argument is a list. Basically, we want to graph a list of values of x between 0 and 2 Pi. (The space between the 2 and the Pi denotes multiplication in Mathematica and Pi, with the capital P, is a built in Mathematica constant.) Lists are denoted by curly brackets { and }.

If the expression is too long to fit on a single line, simple hit the "Return" or "Enter" key and continue typing on the next line. When the entire expression has been entered, you can "evaluate" it, in this case carry out the plotting, by hitting the "Return" or "Enter" key while holding down the "Shift" key. You can click on the plot and drag on the borders to resize it.

In the second plot, there are two functions to plot over the range 0 to 2. These are NOT built in functions so they must be defined (with lower case first letters). The first function y[t_] = t^2 simply defines y as a quadratic function of t. (The semicolon tells Mathematica not to evaluate this expression separately but to wait until it reaches a line without a semicolon and then evaluate all the expressions then.) Note the "_" character following the "t" in the argument of y…this is required in the definition of a function argument. The second function, y2[t_] is simply constant as t varies between 0 and 2. This time the first argument of the Plot function is a list of functions so we enclose them in curly brackets. The second argument is the same variable range list as was used in the first example.

If you make a mistake and want to erase one or more parts of your Mathematica calculation, you can highlight appropriate "brackets" on the right hand side of the window and use Edit -> Cut from the top menu bar.

When you are finished, you can save all your work if you wish to do so in a file (called a notebook or .nb file) and retrieve it when you restart Mathematica.

Mathematica has many commands and options for each command. These are described in the program's online help, in a (very large) book called "The Mathematica Book" by the program's author Stephen Wolfram, which should be available in the Physics Department Lounge, and a variety of other books and web articles. The book "Mathematica by Example" by Abell and Braselton is better organized for learning than "The Mathematica Book" but it has lots of typos. Students interested in physics applications of Mathematica might be interested in the book "Mathematica for Physics" by Zimmerman and Olness. For general reference, Wolfram's "The Mathematica Book" and the program's online help ought to be sufficient.

Exercise: Use Mathematica to plot the amplitude of the damped harmonic oscillator which is given by Exp[-t/2] Cos[2 Pi t] as t varies from 0 to 4.